CLIMATE CHANGE AND **MARINE FISHERIES**

Climate and Impacts Factsheet Series, Factsheet 6 of 7

THE LONG-TERM ADAPTATION SCENARIOS FLAGSHIP RESEARCH PROGRAMME (LTAS) FOR SOUTH AFRICA

The LTAS aims to respond to the South African National Climate Change Response White Paper (NCCRP, para 8.8) by developing national and sub-national adaptation scenarios for South Africa under plausible future climate conditions and development pathways. This will be used to inform key decisions in future development and adaptation planning.

The first phase, completed in June 2013, developed a consensus view of climate change trends and projections for South Africa. It summarised key climate change impacts and potential response options identified for primary sectors, namely water, agriculture and forestry, human health, marine fisheries, and biodiversity.

The second phase will use an integrated assessment approach and model to develop adaptation scenarios for future climate conditions using the information, data and models from Phase 1 and inputs from a range of stakeholder consultations and task-team workshops.

The **Climate and Impacts Factsheet** series has been developed to communicate key messages emerging from LTAS Phase 1, and to complement the LTAS Phase 1 technical reports and the summary for policy-makers.

This factsheet has been developed specifically to provide policy- and decision-makers, researchers, practitioners and community members with up-to-date information on climate change impacts, adaptation responses and future research needs for the marine fisheries sector in South Africa.

The information is built upon past and current research on extractive use and its implications for detecting and projecting climate change impacts, historical trends in fisheries and observed management and policy responses, and advances in projecting climate change impacts.

For further details see the LTAS Phase 1 full technical report entitled *Climate Change Implications for Marine Fisheries in South Africa*.

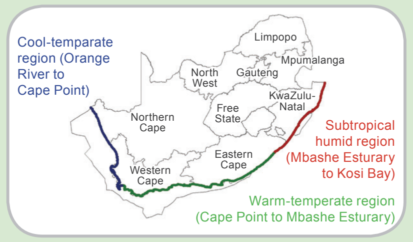
1. Background

South Africa benefits from a wide range of marine resources that contribute to local, national and international food security. Commercial fisheries are concentrated on the western and southern coasts, with recreational and localised subsistence fishing spread along much of the coast. The commercial fishing industry contributes about 1% of GDP, and provides an estimated 27 000 jobs, with more than double the number of jobs in secondary industries such as fish processing, transporting fish products and boat building. Subsistence fishing is important for coastal community livelihoods and food security.

South Africa's marine fisheries depend on coastal and offshore ecosystems (see Box 1), with the main commercial stocks being sardine, anchovy, Cape hake, horse mackerel, rock lobsters, tuna, shark, squid and prawns. Anchovy and sardine are fished the most by volume, and adult stocks depend on the upwelling west coast region of the Benguela Current ecosystem, while the Agulhas Current ecosystem on the south coast is important for their spawning. Hakes, abalone, rock lobsters and squid are among the most valuable resources.

Despite legislation, poorly controlled poaching and illegal fishing are adversely affecting high-value species. Many South African fishery resources are overexploited, with more accessible coastal resources at greater risk. Declines in catches have occurred as a result, but are also due to the shifting distribution of resources linked to environmental variability. South Africa's deep water hake resource is improving in response to the implementation of more precautionary management. Overfishing may result in reduced genetic variability, which may negatively affect the possibilities of an evolutionary response to climate change and the ability of depleted stocks to recover. Stocks under intense exploitation pressure are likely to be more vulnerable to the effects of climate change than optimal exploited populations.

Box 1: South Africa's estuarine, coastal and inshore ecosystems can be divided broadly into three biogeographic regions, namely cool-temperate, warm-temperate, and subtropical humid. These biogeographic regions have been further classified into six coastal and marine inshore and offshore ecoregions made up of 22 ecozones.



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Although many resources are overexploited, management action can lead to stock recovery. Key elements in securing resource sustainability in the long term include robust stock assessments, effective data management and science-based management action grounded in the realities of resource abundance. Implementing the Ecosystem Approach to Fisheries Management can contribute to resource recovery through protection of spawning and nursery areas and the maintenance of other essential fish habitats. Improved bycatch management offers opportunities to reduce waste and derive benefits from non-target species through value adding activities that support job creation. Credible third party eco-certification provides an incentive for responsible fisheries and can deliver additional socio-economic benefits through improved market access and security. Current levels of poaching should be reduced to ensure recovery of key resources and to secure livelihoods of legitimate fishers and their dependent communities.

Marine protected areas (MPAs) and other forms of spatial management are important tools for restoring and sustaining the health of marine biodiversity. They need to be effectively managed to enhance ecosystem resilience under future climate conditions. This can be achieved by preventing and mitigating stressors such as overfishing, pollution and invasive species, as well as establishing and expanding MPAs to maintain ecosystem diversity and resilience, support fisheries management and to maintain connectivity among sites. Policies could encourage diversification of activities and income generation to enhance social resilience in the face of uncertainty and variability, particularly for vulnerable coastal and fisher communities (see Box 6).

BOX 6: ADAPTATION – COMMUNITY LIVELIHOODS

Current adaptation strategies employed to cope with variability include adapting fishing gear and equipment, downsizing or retrofitting boats, and diversifying income streams into motor servicing and boat repairs, and even into other sectors such as agriculture and tourism. Adaptation measures for the communities reliant on fisheries for food and income should also consider options such as education, entrepreneurial training, and training in tourism and aquaculture to prevent potential deterioration of social conditions in fisher communities associated with climate change. Value-adding to current catches and improved market access through eco-certification and other mechanisms could also support fisheries adaptation. Remittances from family members and networks working outside the fishing industry are also important sources of income.

4. Future research needs

Focused research is needed to further develop plausible broad forecasts and more specific predictive capacity and credibility, to support early detection of change and to contribute to the development of appropriate adaptation measures. Improved observations and models are required to link drivers to responses. At present, there are no regional oceanographic models at a stage of development that could reliably inform future climate change scenarios for South African marine areas. In order to make progress on projecting direct impacts of climate change scenarios, additional data collection, synthesis and model development is needed.

Long-term retrospective data analysis can support the development of predictive models for climate change applications. Experimental work on key species would be valuable to understand their adaptive capacity, and to improve projections of the impact of future climate change. The direct and indirect impacts of ocean acidification need to be quantified. Additional research on the socio-economic linkages from climate change impacts on the fisheries sector to other sectors is a priority.

5. Conclusion and linkages

Predicting climate change impacts on marine fisheries is difficult because of the complex relationships between species distribution patterns, variations in their abundance, distribution and productivity, and the impacts of overfishing and other stressors. Key modelling capacity is required to move beyond the current uncertain projections for key fisheries resources under future climate change. In particular a focused effort is required to develop plausible scenarios of physical oceanographic and coastal habitat change. The impacts of unsustainable fishing and climate change interact in a number of ways and should not be treated as separate issues.

Adaptation strategies should centre on sound integrated ecosystem-based management approaches including Integrated Coastal Management and the Ecosystem Approach to Fisheries Management (to complement the current single species approach). At a strategic level management should aim at optimising the inherent ecological buffering capacity of ecosystems against uncertainty and change. Sustainable fishing levels and practices and appropriate spatial management, including climate-resilient MPAs, would be valuable as key elements in South Africa's climate change response strategy. This would support the maintenance of genetic variability to secure genetic potential to adapt to change.

Operationally, fisheries management could usefully include tactics such as improving the speed of adaptive learning cycles, decentralisation and diversification, and enhancing management flexibility to adapt to a changing environment. These could support commercial, subsistence and recreational fishing sectors through improved environmental, resource and social resilience, maintenance of ecosystem, species, genetic and social diversity and the development of adaptive capacity to climate change.

FACTSHEET SERIES PRODUCED BY

SANBI, DEA and GIZ in consultations with relevant sector stakeholders

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- LTAS Phase 1 Methodology
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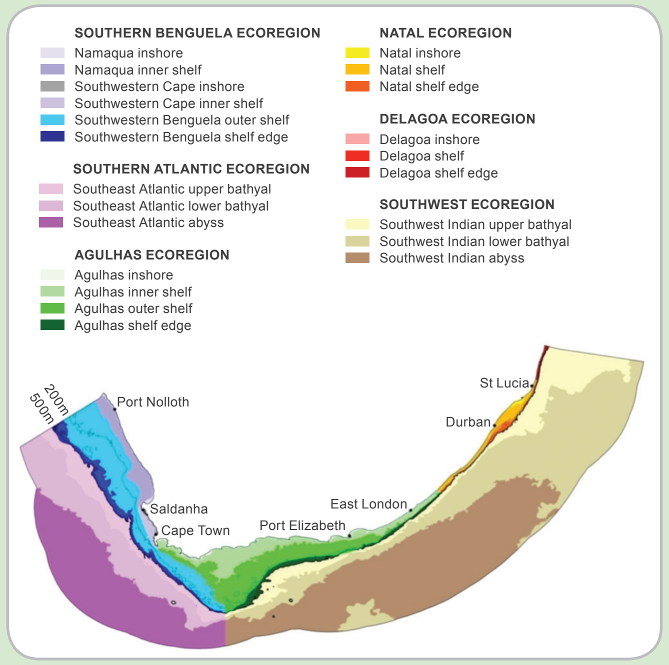
ECOREGIONS AND ECOZONES



2. Climate change impacts on marine fisheries

Understanding and projecting marine ecosystem and fisheries responses to climate change is challenged by knowledge gaps, especially because there are complex relationships between species distributions, variations in their abundance, and the impacts of overfishing and other stressors. Effective modelling is limited by incomplete information on the functioning of biological resources and even more critically the physical changes in the oceans. In particular, most of the global biophysical models currently in use do not simulate the salient features in the oceans around South Africa. These include changes in wind, upwelling, sea surface temperature, productivity, oxygen levels, storm frequency, precipitation, freshwater flow and runoff patterns. These changes will have impacts on estuaries, inshore and offshore ecosystems, and in turn on commercial and subsistence fishing livelihoods and recreational fisheries and their associated industries.

Several marine species have already shifted their geographic ranges as a result of climate variability and change (see Box 2). Changes in distribution patterns can alter the combination of predators, parasites and competitors in an ecosystem, resulting in changes to ecosystem functioning and fishery productivity. Tropical species may move southwards in response to warming temperatures resulting in an expansion of the subtropical region. In contrast, temperate regions may contract, with coastal species being affected by probable upwelling, related extremes in temperatures, reduced runoff and habitat loss ultimately leading to a decrease in temperate species diversity and abundance.

BOX 2. CLIMATE VARIABILITY AND/OR CHANGE – KEY OBSERVATIONS IN RECENT YEARS

- Rising sea levels have been recorded all along South Africa's coastline, but at different magnitudes in different regions.
- Changes in precipitation and fresh water flow, sea-level rise and increased temperatures and coastal storminess have led to changes in physical processes and biological responses in estuaries with an impact on ecosystem services.
- Range extensions of many species of tropical fish into the estuaries of the temperate transition zone have been reported.
- Shifts in the spatial distribution of cold and warm water intertidal species on rocky shores have been linked to changes in wind, upwelling and sea surface temperature.
- An eastward expansion in the distribution of kelp in recent years has been linked to cooling along the south coast.
- Increased coral bleaching on the north east coast has affected reef health.
- An eastward shift in resource availability of West Coast rock lobster has had serious ecological, fisheries and resource management implications.
- Changes in the habitat for small pelagic fish and hakes off the west and south coasts in response to shifts in winds and upwelling were detected in the early 1980s, mid 1990s and in 2009–2010.

BOX 3. POSITIVE IMPACTS OF CLIMATE CHANGE

Climate change may have positive impacts on certain species and their associated fisheries. Changes in sea surface temperature, for example, may limit the possible range of some species but may expand the optimal range available to others. This could result in new fishing opportunities. For example, commercially valuable species may enter new areas and become available for harvest. Some areas may also become more productive, which may increase fisheries yield, but increased productivity may also lead to an increase in low oxygen events that may impact negatively on some resources. Fishers are considered opportunistic and respond to environmental change by adapting their fishing areas, target species and strategies where the management framework supports such adaptation.

Accelerated sea level rise, changes in river flows and increased frequency of high-intensity coastal storms and high water events pose a significant risk to estuarine, inshore and offshore fisheries with potential impacts on linefish, prawns and squid. On a regional scale, KwaZulu-Natal and west coast estuaries are likely to be the most affected from a structural and functional perspective (see Table 1). Offshore catches of important linefish (squaretail kob and slinger) may decrease if freshwater flow inputs are not maintained to key systems such as the Thukela Banks.

Scenarios of more extreme rainfall and dry spells, coupled with sea level rise could cause the loss of nursery habitats essential for prawns and estuarine fish. On the other hand, increases in summer rainfall could result in some estuaries like the St Lucia Estuary opening more frequently, with a positive impact on the abundance of shallow water prawn on the trawl grounds, as long as existing water uses in the catchments feeding these estuaries are better managed.

For both estuarine and marine species, the positive impacts of increases in rainfall could be offset by seasonal shifts in rainfall that could confuse behavioural cues at critical life-history stages such as spawning or migration. Changes in freshwater flow, sea surface temperature, and turbidity (due to increased storm activity) may have implications for the chokka squid fishery and endemic linefish such as white steenbras. Additional temperature extremes and cooling linked to increased coastal upwelling may increase fish mortality (see Box 4).

BOX 4: UPWELLING AND CLIMATE CHANGE

Wind speed, direction and frequency are important drivers of coastal upwelling, which brings cooler, nutrient rich water to the surface. Too much upwelling results in severe hypoxia (reduced oxygen content) in near-shore waters. At present, wind speeds on the west coast are already greater than the optimal level, and any increase in these wind speeds will affect upwelling which may have adverse effects on the fisheries for hake, rock lobster and possibly small pelagic fish.

Estuarine and inshore fisheries in the cool-temperate region would be affected by changes in air and sea surface temperatures, productivity, sea level rise, increased storm frequency, and altered rainfall and river flow patterns. Sea level rise may reduce estuarine nursery habitat, and decreased rainfall may cause temporarily open estuaries to close more frequently or even permanently, impacting on linefish. Over-exploited species (such as temperate linefish species) will be more sensitive to climate effects than optimally exploited species.

BOX 5. IMPACTS ON LIVELIHOODS

An increase in the intensity and frequency of extreme weather events is likely to impact on fishing activity by reducing the number of viable sea fishing days, affecting catches. Furthermore, increased storm intensity is likely to result in damage and destruction to shore-based offloading facilities and fishing vessels, again limiting fisheries success.

Table 1. Climate change drivers, key responses and predicted intensity of response in the three marine biogeographic regions of South Africa's coastline (estuaries and near-shore ecosystems).
dark shading *= high intensity response;*
medium shading = medium intensity response;
light shading = low intensity response.

DRIVERS	RESPONSE	SUB-TROPICAL		WARM TEMP		COOL TEMP
		KwaZulu-Natal	Wild Coast	Eastern Cape	Southern Cape	Western Cape
Ocean circulation	Current speed	+	+	+	+-	+-
	Current position	?	?	?	?	
	Upwelling	+	+	+	+	+
Precipitation	Runoff	+	+	+	+-	-
	Mouth closure	-	-	-	+-	+
	Salinity	-	-	-	+-	+
	Nutrients fluxes	+	+	+	+-	-
	Floods & sediment	+	+	+	+-	-
	Droughts	+	+	+	+	+
	Flushing pollutants	+	+	+	+ -	-
Sea level rise	Salinity	+	+	+	+	+
	Increased tidal prism	+	+	+	+	+
	Mouth closure	-	-	-	-	-
Rising temperatures	Species range extensions	+	+	+-	+-	-
	Community composition	-	-	-	+	+
Acidification	Calcifying organisms	-	-	-	-	-
Coastal storms	Mouth closure	+	+	+	+	+
	Overwash	+	+	+	+	+
	Marine sediment	+	+	+	+	+

Impacts on offshore fisheries depend on distinct scenarios of change in the oceans that would be subject to changes in wind patterns and in offshore currents. Due to a limited understanding of the mechanisms involved, and an incomplete ability to model these, there is currently uncertainty over the impacts on resources. These could include significant spatial shifts in resources driven by changing offshore habitat quality.

3. Adaptation responses

Fisheries that are successfully managed to achieve resource sustainability will be better positioned in the long term to adapt to the effects of climate change. This is because marine resources are likely to be more robust to the effects of climate change if the compounding stresses from overfishing, habitat degradation, pollution and other anthropogenic factors are reduced. Management strategies should include ecosystem-based management practices that focus on rebuilding over-exploited fish resources and impacted ecosystems, maintenance of genetic diversity and improving marine habitat diversity and ecosystem health.